



## White River TMDL

### Technical Memorandum No. 2A (Final)

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*From: Gary Mercer, Heather Cheslek, and Chris Ranck - CDM*

*Date: June 5, 2003*

*Subject: West Fork White River TMDL  
E. coli Bacteria Source Assessment and Load Characterization*

#### Introduction

The State of Indiana assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality assessment results. These water bodies are found on Indiana's 305(b) list as required by that section of the CWA that defines the assessment process, and are published every two years.

Some of the 305(b) partially and not supporting water bodies are also assigned to Indiana's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

Water quality data was collected from the West Fork White River in Marion County and south to Waverly. Data collected by Indiana Department of Environmental Management (IDEM) indicate that the river does not comply with the following water quality standards:

- *E. coli* bacteria
- Ammonia
- Cyanide
- Dissolved Oxygen

As a result, this portion of the White River was added to the State's 1998 303(d) list and scheduled for a TMDL evaluation.

## Water Quality Assessment

Previous issued technical memorandums (TM 1A, 1B and 1C) document the existing water quality for White River. The findings of the previous memos indicate that the *E. coli* bacteria standard of 125 cfu per 100 ml (geometric mean of 30 days) and 235 cfu per 100 ml (maximum day value) are often exceeded on the river. **Tables 1** present summary of the findings of the *E. coli* bacteria counts in the river from TM 1C.

The draft 2002 303(d) proposes to remove ammonia from the list. The ammonia criteria recently changed in 1999 and the new criteria was adopted by IDEM in 2002. The findings indicate that the instream ammonia concentrations are below the new standard.

An earlier analysis indicated that the primary source of cyanide is the City's advanced wastewater treatment plants (AWTs) at Belmont and Southport. The instream water quality monitoring data supports this finding. Hence, control of cyanide is primarily a NPDES permit question associated with the AWTs

Low dissolved oxygen which can violate the instream water quality standard is caused by CSO discharges. The City's CSO Long-term Control Plan is being developed to reduce or eliminate the occurrence of low dissolved oxygen.

This technical memorandum will focus on the source and instream counts of *E. coli* bacteria.

## Source Assessment and Load Characterization for *E. coli* Bacteria

A source assessment is used to characterize the known and suspected sources of *E. coli* bacteria in the watershed for use in the water quality model, and the development of the TMDL. There are two NPDES wastewater treatment facilities on the White River, the Belmont and Southport AWT plants, which both discharge *E. coli* bacteria

The *E. coli* bacteria for this TMDL was characterized for the following sources:

- Septic systems
- Illicit connections to storm drains
- Advanced wastewater treatment plants
- Wildlife/Natural
- Stormwater runoff
- Combined sewer overflows
- Upstream sources

All sources of *E. coli* bacteria identified in the two watersheds are assigned a loading rate based on data from the City of Indianapolis, literature values and population in the watershed. Because of varying decay or die-off rates for *E. coli* bacteria, and varying transport assumptions, the *E. coli* bacteria loading from these sources are computed separately in the model as described in the following sections.

### Failing Septic Systems

Failing septic systems have been linked to increased *E. coli* bacteria levels in streams throughout the world. In accordance with the City of Indianapolis' Barrett Law program, a list of neighborhoods with failing septic systems is kept and updated based on new information. Scheduling of sewer projects in each neighborhood is partially based on the degree of system failure that is observed. The failure information has been obtained for the period of 2000 through 2002 and was compared to sampling data for that same period.

As of early 2000, there was one priority-1 septic neighborhood within the watershed boundary that directly drains into the White River within Marion County, as well as 15 priority-2 and 20 priority-3 septic neighborhoods. For areas draining into one of the tributary streams, there are approximately 30 priority-1 septic neighborhoods, 22 priority-2 septic neighborhoods, and 26 priority-3 septic neighborhoods. The number of septic systems in each watershed was estimated based on IMAGIS (Indianapolis Mapping and Geographic Infrastructure System) coverages for septic neighborhoods, buildings, and watersheds. *E. coli* bacteria loads were estimated based on an assumed failure rate, flow rate, and *E. coli* counts for the septic neighborhoods. For purposes of the TMDL analysis, the failure rate for a septic system is related to the priority of the area as follows:

- Priority 1: 25% failure rate
- Priority 2: 15% failure rate
- Priority 3: 10% failure rate
- All others: 5% failure rate

A flow of 100 gallons/person-day and a concentration of 10,000 cfu per 100 ml (Horsley and Whitten, 1996) to each failing septic system were assigned. Leaking septic systems are included in the water quality model as a point source having constant flow and concentration. The loading rate attributed to leaking septic systems is estimated to be  $4.66 \times 10^{10}$  cfu per day. **Table 2** summarizes the estimated septic *E. coli* bacteria loadings into White River.

### Illicit Discharges to Storm Drains

Stormwater outfalls often carry *E. coli* during dry weather because of loadings from illicit sanitary connections to the stormwater collection system. The City of Indianapolis Fifth Annual Report (2002) (AMEC, 2003) reported that approximately 7.7% of the stormwater

outfalls sampled contained dry weather flows. For each illicit discharge, a flow of 20 gpd with 10,000 cfu per 100 ml for *E. coli* bacteria was assigned. **Table 3** summarizes the estimated illicit storm drain *E. coli* loadings into White River.

### **Advanced Wastewater Treatment Plants**

As a requirement of the City of Indianapolis Advanced Wastewater Treatment Plants' NPDES permits, the treatment plant influent and effluent is monitored for *E. coli* bacteria. **Table 4** summarizes the estimated *E. coli* loadings into the White River from the Belmont and Southport AWTs.

### **Wildlife and Natural Background**

Not all *E. coli* bacteria in waterways are the result of man-made sources. Wildlife, both instream and on-bank can be a source of *E. coli* Bacteria to the streams. To estimate the potential load from wildlife, the instream monitoring station at 71<sup>st</sup> Street on Fall Creek was utilized. The land use above 71<sup>st</sup> Street indicates natural conditions with few anthropogenic, or human caused, sources. The area above 71<sup>st</sup> Street has a fully developed storm sewer system that contributes to Fall Creek, but this should not contribute a significant amount of *E. coli* bacteria during dry weather flow conditions. The *E. coli* Bacteria monitoring data from this station was used to represent the wildlife or natural *E. coli* Bacteria load into the streams. **Table 5** summarizes the estimated *E. coli* concentrations and loadings into White River that are a result of natural biota in the watersheds.

### **Stormwater Runoff**

Stormwater often carries *E. coli* because of loadings from domestic animals, wildlife, and agricultural land. Information from the City of Indianapolis' stormwater program and GIS coverages provided insight into the contribution of stormwater to the *E. coli* exceedences seen in Fall Creek and Pleasant Run and showed what progress has been made thus far in alleviating that contribution. Average stormwater *E. coli* counts were estimated from IMAGIS landuse and watershed coverages. These counts were applied to daily surface runoff flows from October 1991 to October 2001 predicted using the City's watershed model (NETSTORM). **Table 6** contains a summary of the average daily surface runoff flows and *E. coli* loadings into White River based on land use. **Table 6B** shows the percentages of stormwater loads into White River that come from permitted (storm drain outfall), non-permitted (surface runoff), and out-of-county sources.

### **Combined Sewer Overflows**

Combined Sewer Overflows (CSOs) can be a large source of *E. coli* in urban streams. The CSO flows and *E. coli* bacteria loadings were determined in a methodology similar to those presented in the CSO Control Technologies Evaluation (CDM, 2003) document. CSO discharges were predicted by the City's collection system model for a ten year period of time (October 1991 to October 2001). *E. coli* sampling of CSO discharges were performed by the

City in 2001 to characterize CSO discharges. Concentrations ranged from 500,000 cfu per 100 ml up to 900,000 cfu per 100 ml. The CSO flows and *E. coli* loads were predicted using the City's model and sampling data. **Table 7** contains a summary of the estimated *E. coli* loadings from CSOs on White River and to the tributaries of the White River.

## Out of County *E. coli* Contributions

In addition to the in-county sources discussed above, the White River receives *E. coli* bacteria from various sources in Hamilton County and the watershed north. For the purposes of this analysis, the upstream loadings were assumed constant for dry-weather and wet-weather flow conditions, and are summarized in **Table 8**.

## Description of Daily *E. coli* Bacteria Model

A comprehensive model of the White River from Marion County downstream to Waverly was developed and calibrated to the existing instream *E. coli* bacteria data. The model simulated the daily instream bacteria counts for each stream segment based on loads from the sources described above. For the dry weather sources, a constant load was applied, whereas for stormwater runoff and CSO discharges, the *E. coli* load was based on the City's watershed model (for stormwater) and collection system model (for CSO discharges). A ten year period of time (October 1991 through September 2001) was simulated. Data on stream flow was used to predict the resultant instream *E. coli* Bacteria counts for each day for the ten year period.

Daily flow data for the White River – Indianapolis (USGS Gauge # 3353000) and at the Stout Station (USGS Gauge # 3353611) was obtained from the USGS for the period of October 1, 1991 through September 30, 2001. Daily flow data was used for the daily *E. coli* model

**Table 9** presents a sample page from the daily *E. coli* bacteria model for the White River – CSO area. **Figure 1** presents the predicted instream *E. coli* bacteria counts for April 1, 1997 to October 31, 1997 for the CSO area and **Figure 2** presents for the downstream of the CSO area.

Model calibration consisted of comparisons of the geometric mean, percent of samples over 235 cfu/100 ml and the number of samples over 10,000 cfu/100 ml per year of sampling. These comparisons were performed for both dry-weather and wet-weather data. The calibration of the mass balance model for *E. coli* bacteria included QAQC of the USGS daily flow data, adjustment for *E. coli* contributions from wildlife for all reaches, adjustment for the Pleasant Run septic flow *E. coli* contributions, and for *E. coli* bacteria contributions from stormwater. **Table 10** contains a summary of the observed and modeled *E. coli* bacteria loadings parameters for the watersheds modeled. **Table 11** summarizes the daily septic, illicit, wildlife, stormwater, and CSO *E. coli* loadings into White River.

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## **Next Step**

The next step in the TMDL process is to examine *E. coli* bacteria load reduction scenarios to determine attainment of water quality standards.

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## Table 1: *E. coli* Bacteria Compliance

All Data				
River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
White River - Upstream of Lake Indy	166	32.9%	1	155
White River - Within CSO Area	238	46.2%	3	184
White River - Downstream of CSO Area	410	63.8%	1	47
Dry Weather				
River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
White River - Upstream of Lake Indy	74	19.1%	0	47
White River - Within CSO Area	99	25.3%	0	91
White River - Downstream of CSO Area	165	44.0%	0	25
Wet Weather				
River Segment	Geometric Mean of 2000-2002 data	% of Samples > 235 cfu/100 ml	Number of Samples > 10,000 cfu/100 ml <sup>(2)</sup>	Total Number of Samples
White River - Upstream of Lake Indy	236	38.9%	1	108
White River - Within CSO Area	561	66.7%	3	93
White River - Downstream of CSO Area	1159	86.4%	1	22

State Guidance<sup>(1)</sup>

(IDEM standard of 125 cfu/100 ml)

(IDEM Guidance 10% or less)

(IDEM Guidance None > 10,000 cfu/100 ml)

<sup>(1)</sup> Indiana's 303(d) Listing Methodology for Impaired Waterbodies and Total Maximum Daily Load - September 2002

<sup>(2)</sup> Samples over 10,000 cfu/100 ml are normalized for the 1.5 year sampling period

**TABLE 2: FAILING SEPTIC SYSTEMS  
WHITE RIVER**

Watershed	Approximate Count of Septic Systems				Total Septics	Estimated Failing Septic Systems	Approximate Population	Estimated Failing Septic Flow (MGD)	Estimated Failing Septic Daily Load (cfu)	Estimated Failing Septic Monthly Load (cfu)
	Barrett Law Priority 1	Barrett Law Priority 2	Barrett Law Priority 3	Non-Barrett Law						
Howland & Johnson Ditch	0	130	1044	0	1174	124	434	0.04	1.64E+10	4.92E+11
Crooked & Williams Creek	908	8	840	44	1800	314	1100	0.11	4.17E+10	1.25E+12
White River North	0	867	1614	78	2559	295	1034	0.10	3.91E+10	1.17E+12
Eagle & Guion Creek***	158	433	563	78	1232	165	576	0.06	2.18E+09	1.64E+11
White River CSO	0	667	430	215	1312	154	538	0.05	2.04E+10	6.11E+11
State Ditch, Buck & Lick Creek****	1188	1416	838	1162	4604	651	2280	0.23	2.16E+10	6.47E+11
White River South	108	620	612	253	1593	194	678	0.07	2.57E+10	7.70E+11
<b>Assumed Failure Rate</b>	<b>25%</b>	<b>15%</b>	<b>10%</b>	<b>5%</b>						
<b>Totals</b>	<b>2362</b>	<b>4141</b>	<b>5941</b>	<b>1830</b>	<b>14274</b>	<b>1897</b>	<b>6640</b>	<b>0.66</b>	<b>1.67E+11</b>	<b>5.11E+12</b>

\*Assumptions include 3.5 persons per septic system, 100 gpcd septic flow, and 10,000 cfu/100 ml E. coli in the septic flow

\*\*Persons per system and per capita flows taken from May 1989 DPW Design Standards

\*\*\*Considered a secondary input with reduced loading into the White River CSO Reach(1,000 cfu/100 ml E. coli in septic flow)

\*\*\*\*Considered a secondary input with reduced loading into the White River South Reach(2,500 cfu/100 ml E. coli in septic flow)

**TABLE 3: ILLICIT CONNECTIONS TO STORM DRAINS  
WHITE RIVER**

Watershed	# of Storm Outfalls	Miles of Storm Sewer and Drains	Approximate number of Illicit Connections	Illicit Flow (MGD)	Estimated Illicit Connection Daily Load (cfu)	Estimated Illicit Connection Monthly Load (cfu)
White River North	29	131	2	4.00E-05	1.51E+07	4.54E+08
White River CSO	150	119	12	2.40E-04	9.08E+07	2.73E+09
White River South	20	152	2	4.00E-05	1.51E+07	4.54E+08
Howland Ditch	Included in White River North Summary					0.00E+00
Crooked Creek & Johnson Ditch	123	196	9	1.80E-04	6.81E+07	2.04E+09
Williams Creek	59	72	5	1.00E-04	3.79E+07	1.14E+09

\*Illicit Connections assumed at 7.7% of outfalls (based on 2002 NPDES Stormwater report sampling data)

20 gpd sanitary flow, and 10,000 cfu/100 ml E. coli in the illicit flow

**TABLE 4: AWT TREATED EFFLUENT  
WHITE RIVER**

Watershed	AWT Discharge	Average Discharge Flow (MGD)	Average E. coli Concentration (cfu/100 ml)	Average Daily AWT Load (cfu)	Average Monthly AWT Load (cfu)
White River CSO	Belmont	96	30	1.26E+11	3.77E+12
White River South	Southport	79	52	1.60E+11	4.79E+12

\*E. Coli discharges not monitored from January to March

\*AWT data recorded from April through October 2002 MOR's

**TABLE 5: INSTREAM WILDLIFE  
WHITE RIVER**

Watershed	Average Dry-Weather E. coli (cfu/100 ml)	Average Dry-Weather stream flow (cfs)	Approximate Instream Wildlife Daily Load (cfu)	Estimated Instream Wildlife Monthly Load (cfu)
White River North	33	104	8.40E+10	2.52E+12
White River CSO	5	78	9.49E+09	2.85E+11
White River South	48	546	6.41E+11	1.92E+13

\*The 71st Street Sampling Station along Fall Creek is not in close proximity to any septic systems. Its dry-weather observed E. coli bacteria concentrations are assumed to be the result of wildlife. This concentration is applied to all other streams

\*These concentrations were later adjusted to match observed daily data

**TABLE 6: STORMWATER RUNOFF FROM SEPARATE SEWER AREAS  
WHITE RIVER**

Landuse Type	Approximate Percentage of Specified Landuse								Approximate Average E. Coli Concentration (cfu/100 ml)	Daily Average Stormwater Flow (cfs)	Daily Average Stormwater Load (cfu)
	Commercial	Residential	Historic & Hospital	Industrial	Parks	Highway ROW	Spec. Uses	University			
Zoning Class	All C's	All D's	All H's	All I's	All PK's	ROW, RC	All SU's	All U's			
Assumed E. coli concentration	2000	2250	2500	2000	2500	3000	2500	2000			
White River Upstream	12%	68%	3%	4%	2%	2%	9%	0%	2300	81	4.54E+12
White River CSO	8%	48%	1%	22%	7%	3%	8%	4%	2200	35	1.90E+12
White River South	5%	67%	0%	12%	2%	1%	13%	0%	2300	22	1.24E+12

**TABLE 6B: UNPERMITTED AND PERMITTED STORMWATER RUNOFF SOURCES  
WHITE RIVER**

Watershed	Permitted Storm Sewer Area (Acres)	Area without Storm Sewers (Acres)	Area outside County (Acres)	Total Area (Acres)	% Permitted	% Unpermitted	% Out of County
White River North*	24,000	-	254,000	278,000	9%	0%	91%
White River CSO**	12,000	3,000	-	15,000	80%	20%	0%
White River South***	43,000	9,000	-	52,000	83%	17%	0%

\*Includes Howland & Johnson Ditch, Crooked Creek & Williams Creek

\*\*Includes Eagle & Guion Creek

\*\*\*Includes State Ditch, Lick Creek, and Buck Creek

**TABLE 7: COMBINED SEWER OVERFLOWS  
WHITE RIVER**

Watershed	# Of CSO Regulators	# of CSO Outfalls	Annual Average CSO Volume (MG)	Average CSO E. Coli Concentration (cfu/100 ml)	Annual Average CSO E. Coli Load (cfu)	Daily Average CSO E. Coli Load (cfu)	Monthly Average CSO E. Coli Load (cfu)
Fall Creek CSO	35	26	1713	9.33E+05	4.02E+16	1.10E+14	3.30E+15
Pleasant Run CSO	51	51	334	1.21E+06	1.51E+16	4.13E+13	1.24E+15
White River CSO	35	26	1110	1.01E+06	5.23E+16	1.43E+14	4.30E+15
Pogues Run CSO	24	23	1046	1.28E+06	4.67E+16	1.28E+14	3.84E+15
Eagle Creek CSO	N/A	N/A	66	7.19E+05	2.05E+15	5.62E+12	1.69E+14

\*Flows and bacteria loadings are from the 50-year rainfall record

\*\*White River regulator and outfall counts include Eagle Creek

**TABLE 8: HAMILTON COUNTY FLOW  
WHITE RIVER**

Watershed	Average E. coli (cfu/100 ml)	Average stream flow (cfs)	Approximate Hamilton Co. Daily Load (cfu)	Estimated Hamilton County Monthly Load (cfu)
Hamilton County -- Dry*	60	229	3.36E+11	1.01E+13
Hamilton County -- Wet**	186	229	1.04E+12	3.13E+13

\*The dry-weather geometric mean of the 96th street sampling station was assumed to be the Hamilton Co. dry-weather concentration

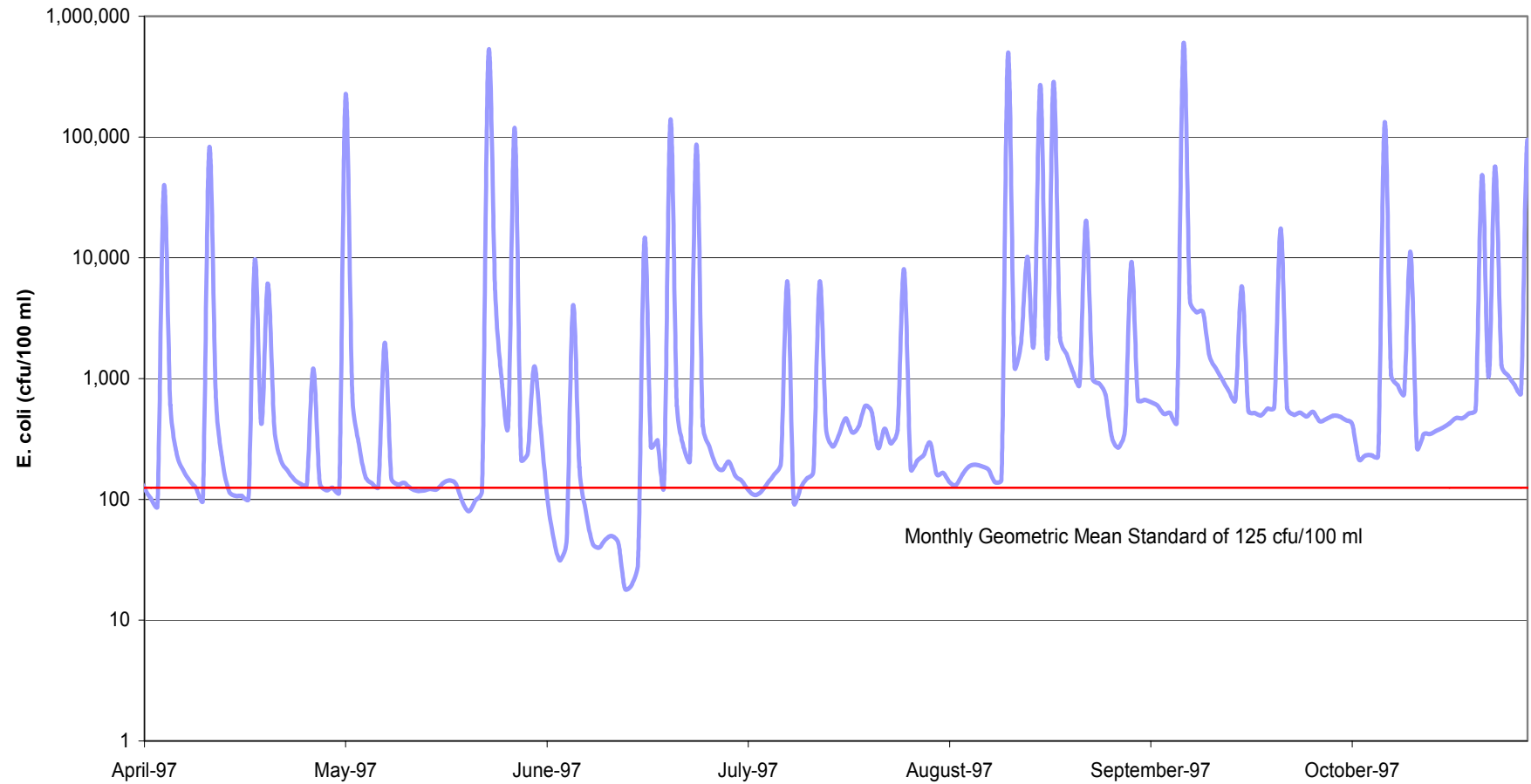
\*This concentration was later adjusted to match observed daily data

\*\*The wet-weather gemetric mean of the 96th street sampling station was assumed to be the Hamilton Co. wet-weather concentration

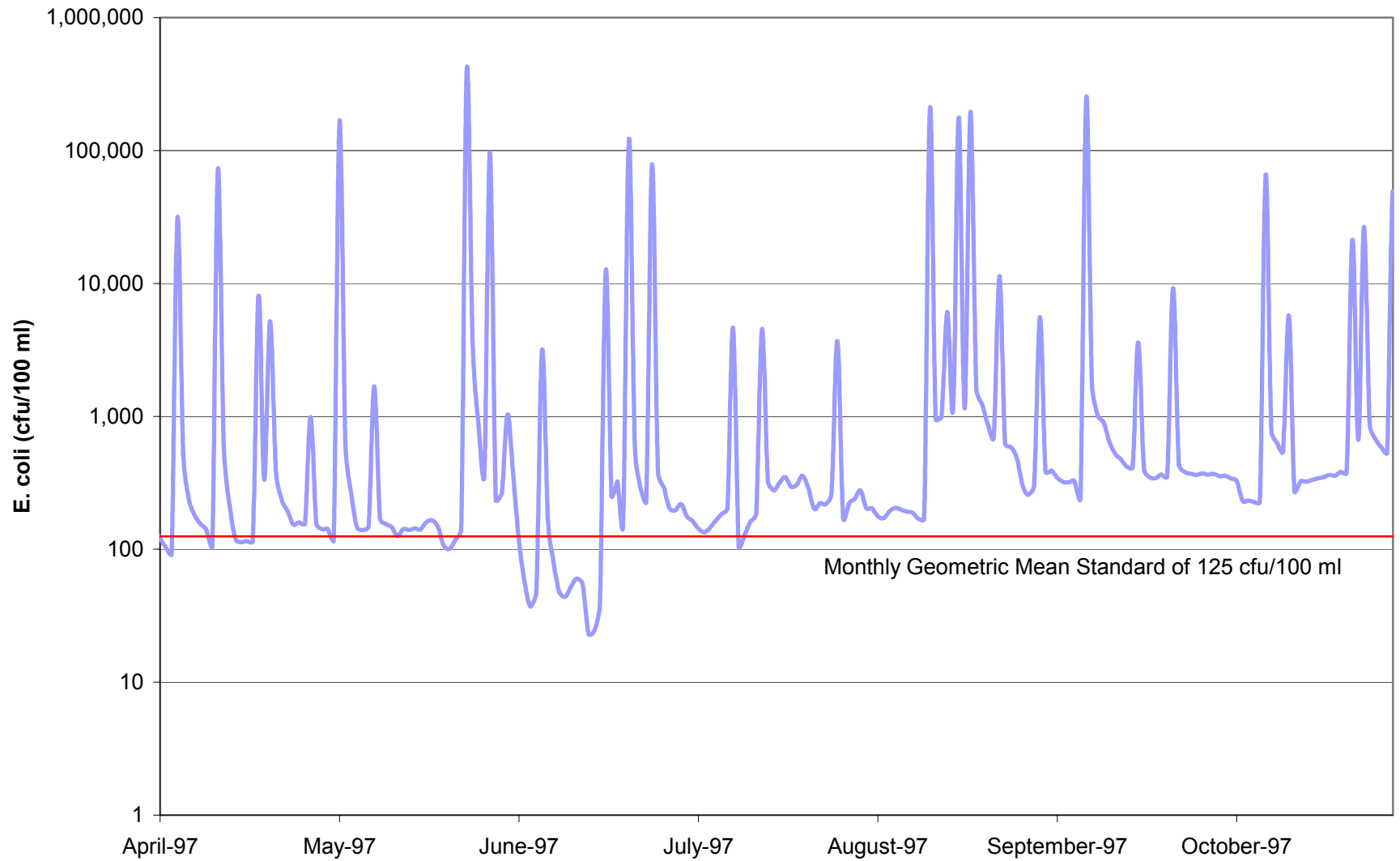
TABLE 9: SAMPLE OF WHITE RIVER CSO AREA DAILY E. COLI COUNTS

Date	Average Daily Flow (cfs)	CSO Flow (cfs)	Total Flow (cfs)	Hamilton Co. Load (cfu/day)	Septic Load (cfu/day)	Illicit Load (cfu/day)	AWT Load (cfu/day)	Wildlife Load (cfu/day)	Stormwater Runoff Load (cfu/day)	CSO Load (cfu/day)	Total Load (cfu/day)	Resulting Concentration (cfu/100 ml)
10/1/1991	83	0	83	3.36E+11	1.34E+11	2.84E+08	1.26E+11	1.15E+11	0.00E+00	0.00E+00	7.11E+11	350
10/2/1991	67	0	67	3.36E+11	1.34E+11	2.84E+08	1.26E+11	1.15E+11	0.00E+00	0.00E+00	7.11E+11	434
10/3/1991	143	8	151	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	5.07E+12	1.98E+14	2.04E+14	55,505
10/4/1991	116	0	116	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.25E+12	0.00E+00	2.66E+12	939
10/5/1991	319	101	420	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.71E+13	2.59E+15	2.62E+15	254,814
10/6/1991	221	0	221	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	8.41E+12	0.00E+00	9.83E+12	1,818
10/7/1991	178	0	178	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	4.94E+12	0.00E+00	6.36E+12	1,460
10/8/1991	150	0	150	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	3.18E+12	0.00E+00	4.59E+12	1,251
10/9/1991	129	0	129	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.14E+12	0.00E+00	3.55E+12	1,126
10/10/1991	173	3	176	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	4.34E+12	6.59E+13	7.17E+13	16,689
10/11/1991	156	0	156	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.08E+12	0.00E+00	3.50E+12	918
10/12/1991	117	0	117	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.38E+12	0.00E+00	2.80E+12	979
10/13/1991	106	0	106	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	9.72E+11	0.00E+00	2.39E+12	921
10/14/1991	120	1	121	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.11E+12	3.62E+13	3.97E+13	13,367
10/15/1991	125	0	125	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.21E+12	0.00E+00	2.63E+12	859
10/16/1991	110	0	110	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	7.67E+11	0.00E+00	2.18E+12	812
10/17/1991	110	0	110	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	5.33E+11	0.00E+00	1.95E+12	725
10/18/1991	116	0	116	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	3.82E+11	0.00E+00	1.80E+12	634
10/19/1991	113	0	113	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	6.68E+11	0.00E+00	2.08E+12	754
10/20/1991	117	0	117	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	3.33E+11	0.00E+00	1.75E+12	611
10/21/1991	127	0	127	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.20E+11	0.00E+00	1.64E+12	527
10/22/1991	128	0	128	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.52E+11	0.00E+00	1.57E+12	501
10/23/1991	127	0	127	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.08E+11	0.00E+00	1.52E+12	491
10/24/1991	136	1035	1171	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.16E+11	2.67E+16	2.67E+16	930,498
10/25/1991	265	0	265	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	3.79E+13	0.00E+00	3.94E+13	6,071
10/26/1991	2540	0	2540	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.04E+14	0.00E+00	2.06E+14	3,308
10/27/1991	1710	0	1710	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	9.62E+13	0.00E+00	9.76E+13	2,334
10/28/1991	994	0	994	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	3.22E+13	0.00E+00	3.36E+13	1,383
10/29/1991	654	0	654	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.50E+13	0.00E+00	1.64E+13	1,027
10/30/1991	393	7	400	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	8.17E+12	1.82E+14	1.92E+14	19,614
10/31/1991	294	0	294	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	4.91E+12	0.00E+00	6.33E+12	880
11/1/1991	332	0	332	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	6.58E+12	0.00E+00	8.00E+12	985
11/2/1991	306	0	306	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	4.13E+12	0.00E+00	5.54E+12	740
11/3/1991	251	0	251	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.57E+12	0.00E+00	3.99E+12	649
11/4/1991	228	0	228	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.86E+12	0.00E+00	3.28E+12	588
11/5/1991	223	0	223	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.29E+12	0.00E+00	2.71E+12	496
11/6/1991	211	0	211	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	9.17E+11	0.00E+00	2.33E+12	452
11/7/1991	197	0	197	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	1.13E+12	7.77E+12	1.03E+13	2,138
11/8/1991	208	0	208	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	6.99E+11	0.00E+00	2.12E+12	416
11/9/1991	204	0	204	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	4.86E+11	0.00E+00	1.90E+12	381
11/10/1991	199	0	199	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	3.53E+11	0.00E+00	1.77E+12	364
11/11/1991	197	0	197	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.61E+11	0.00E+00	1.68E+12	348
11/12/1991	203	1	204	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	9.62E+11	2.22E+13	2.46E+13	4,933
11/13/1991	196	0	196	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	4.72E+11	0.00E+00	1.89E+12	394
11/14/1991	190	1	191	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	2.78E+11	1.39E+13	1.56E+13	3,345
11/15/1991	200	0	200	1.04E+12	1.34E+11	2.84E+08	1.26E+11	1.15E+11	5.70E+11	0.00E+00	1.99E+12	406

**Figure 1: White River CSO Area Daily E. coli Counts**  
**April 1, 1997 through October 31, 1997**



**Figure 2: White River South of CSO Area Daily E. coli Counts**  
**April 1, 1997 through October 31, 1997**



**TABLE 10: COMPARISON OF OBSERVED AND MODELED E. COLI COUNTS  
WHITE RIVER**

Stream Reach	Geometric Mean			% of Days > 235			# of Samples >10000 Per Year		
	All	Dry	Wet	All	Dry	Wet	All	Dry	Wet
White River-Upstream Measured	166	74	236	33%	19%	39%	1	0	1
White River-Upstream Modeled	181	73	210	40%	0%	43%	0	0	0
White River-CSO Measured	238	99	561	46%	25%	67%	3	0	3
White River-CSO Modeled	459	113	551	54%	19%	56%	37	0	37
White River-South Measured	410	165	1159	64%	44%	86%	1	0	1
White River-South Modeled	455	166	539	56%	33%	58%	35	0	35

\*Measured *E. Coli* Counts are reported in Table 1

**TABLE 11: TOTAL AVERAGE E. COLI DAILY LOAD  
WHITE RIVER**

Watershed	Average Daily Septic Load (cfu)	Average Daily Illicit Connection Load (cfu)	Average Daily Wildlife Load (cfu)	Average Daily AWT Load (cfu)	Average Daily Stormwater Load (cfu)	Average Daily CSO Load (cfu)	Total Average Daily Load (cfu)	Total Cumulative Daily Load (cfu)
Inflow from Hamilton County			3.36E+11		7.06E+11		1.04E+12	
Howland & Johnson Ditch	1.64E+10	0.00E+00	9.79E+08				1.74E+10	
Crooked & Williams Creek	4.17E+10	1.06E+08	9.79E+08				4.27E+10	
White River North	3.91E+10	1.51E+07	8.40E+10		4.54E+12		4.66E+12	<b>5.76E+12</b>
Fall Creek -- Reduced 75% for Dry Weather	1.16E+10	4.35E+07	1.94E+10		1.76E+12	1.10E+14	5.60E+13	
Pleasant Run -- Reduced 75% for Dry Weather	2.39E+09	2.84E+07	4.89E+08		2.99E+11	4.13E+13	2.08E+13	
Pogues Run CSO						1.28E+14	1.28E+14	
Eagle Creek CSO						5.62E+12	5.62E+12	
White River CSO	2.26E+10	9.08E+07	9.49E+09	1.26E+11	1.90E+12	1.43E+14	1.45E+14	<b>3.61E+14</b>
White River South	4.73E+10	1.51E+07	6.41E+11	1.60E+11	1.24E+12		2.08E+12	<b>3.64E+14</b>

\*Note: Flows for Howland Ditch, Crooked Creek, Johnson Ditch, and Williams Creek are not currently known. The bacteria loading was assumed to be the same as Pleasant Run

\*\*Note: Stormwater loads for Howland Ditch, Crooked Creek, Johnson Ditch, and Williams Creek are lumped into the White River loads

\*\*\*Note: Septic Loads from Eagle and Guion Creeks are lumped into the White River CSO Loads

\*\*\*\*Note: Septic Loads from State Ditch, Lick Creek, and Buck Creek are lumped into the White River South Loads